The Large-Scale Digital Cell Analysis System: A Unique Tool for the Study of Molecular and Cellular Phenomena in Living Cell Populations

Mackey, M.A.*[1], Anderson, K.R.[2], Bresnahan, L.[2], Domann, F.E.[2], Gallardo, G.[2], Ianzini, F.[2], Kosmacek, E.A.[2], Li, Y.[2], Sonka, M., Spitz, D.R.[2], Sun, Y.[2], Wang, L.[2], Yang, F[2]
[1]Biomedical Engineering/Pathology, University of Iowa, Iowa, USA; [2]University of Iowa, Iowa, USA

The Large Scale Digital Cell Analysis System (LSDCAS) is a collection of automated microscope systems and analysis techniques dedicated to performing live cell measurements under controlled laboratory conditions. The overall philosophy underlying LSDCAS development is to provide the biomedical research community at large with a new set of tools for the analysis of living populations of cells. LSDCAS is capable of imaging thousands of living cells for a period of a few days up to weeks in a single experiment. In addition to its native data formats, digital motion pictures (MPEG movies) are produced and archived to DVD-ROM for later analysis and display. LSDCAS is comprised of over 30,000 lines of programming code in C++. For our current configuration, LSDCAS produces peak data acquisition rates of about 40 gigabytes per week, thus requiring rather significant computer and analytical resources. At this time, LSDCAS consists of two automated microscope systems, a dedicated, highly-available Storage Area Network Data Center (2 quad Itanium servers - 2 terabytes FC raid storage - 30-slot DLT tape library), 15 analysis / acquisition workstations, and tissue culture support apparatus. All software runs on the Linux operating system; DEC alpha, itanium, and 386-based processor hardware is supported. LSDCAS has been established as an Open Source project released under the GNU General Public License, and is being used in the study of cell death, cell motility, measurement of intracellular pro-oxidant species, and the determination of phenotypic changes observed using adenovirus-mediated gene expression systems. Quantitative analyses of segmented images are used in modeling studies based upon a thermodynamic theory of steady-state phenomena under active development in our group. Other applications of LSDCAS technology are under development within interdisciplinary collaborative interactions at the University of Iowa. It is expected that the analytical capabilities of LSDCAS will continue to grow in the near future.